

# ***Interactive comment on “Late Glacial-Holocene climatic transition record at the Argentinian Andean piedmont between 33–34° S” by A. E. Mehl and M. A. Zárate***

**J.-H. May (Referee)**

hmay@uow.edu.au

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## 1. General Comments:

The paper “Late Glacial-Holocene climatic transition record at the Argentinean Andean piedmont between 33–34°S” (original title: “Alluvial record and paleosol formation during the Pleistocene-Holocene climatic transition at the eastern Andean piedmont between 33–34° S, Argentina”) by A. Mehl and M. Zárate presents results from the pedogenic and micromorphological analysis of a prominent paleosol formed within a well-exposed Late Pleistocene to Holocene aggradational sequence of large regional significance for the reconstruction of past environments and climates in southern South

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America. Despite the increasing number of comparable studies in the Pampas or along other parts of the Andean piedmont, there are still very few published records of paleoenvironmental changes in the late Quaternary available, so this paper is a valuable and welcome contribution towards an improved understanding of regional climate and landscape evolution in southern South America!! In addition, the paper specifically looks at a paleosol formed during the Late Glacial - early Holocene transition (LG-EH) and thereby targets a time interval of regional AND global paleoclimatic relevance. It is generally well structured, of appropriate length and has good quality illustrations/artwork. It follows up on previously published research on the alluvial stratigraphy, chronology and pollen record in this sequence, and adds a good amount of new micro-morphological and pedological detail for the studied paleosol. In summary, I therefore believe that the scope of the paper and the presented data merit publication in “Climate of the Past” after addressing and including some suggestions, which I hope will help to improve the clarity of the paper in a number of aspects:

## 2. Specific Comments:

In general, I agree with the overall structure of the paper but would suggest an improved structure for the discussion chapter. In order to support the author’s line of argument and increase the overall clarity of the discussion, it could be divided into subchapters which build on each other (“zoom out”) – and successively address the various scales of interpretation: (i) What do micromorphology and pedogenic processes mean for the resulting soil types and local environments (soil forming processes)? (ii) In how far would these processes relate to regional climate vs site specific geomorphic conditions (e.g. the activity of the fluvial system, which in itself could be controlled by climate)? (iii) How does this compare to a) other paleosol-sediment-sequences and b) other paleoclimate proxies (e.g. pollen, speleothems) in southern South America, and (iv) which could be the responsible hemispheric or global drivers...?!

In addition, the following comments and suggestions will highlight that I am not fully convinced by the line of arguments the authors apply to support their conclusion of

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climate as the main driver of the LG-EH paleosol (I do agree that climate is the major driver, but would like to see more discussion of the geomorphic relevance and context of the paleosol):

- p. 6139, line 1-2: “higher frequency of flooding events” – This interpretation needs to be backed up or discussed with more detail, and in my opinion shows that the paleoenvironmental significance of any sediment and paleosol also depends on its stratigraphic context of the sedimentary environment in which it forms (in this example, the relation to the channel). Why would laminated sediments indicate higher frequency? Could also mean that the channel at that time was getting closer to the study site (by lateral migration), or do you have any indications where it was during this time? Alternatively, it could mean that flood magnitudes (instead of frequencies) increased, with flooding now occurring in places which were previously unaffected by overbank. This would indicate a major change in fluvial dynamics providing the stability for pedogenic processes to form well-developed soil horizons, but requires the discussion of both (i) the fluvial system and vegetation/sediment yield relations, AND (ii) the paleosol.

- p. 6138, line 1-3: Are there any indications for an elevated position in the floodplain? Of all sedimentary environments, I would expect floodplains to be comparatively flat, so the pedogenic development of the paleosols in the same floodplain should be very similar? Could the topographic variations be the result of more patchy aeolian forms and deposits which underlay the paleosol (i.e. meaning that the soils are not “floodplain soils”)?

Also, I am unsure of the author’s conclusion of climatic “amelioration” in southern Mendoza during the early Holocene, and hope the authors could add more detail to their arguments, clarifying their paleoenvironmental and/or paleoclimatic interpretation of the LG-EH paleosol. Here some thoughts and comments to consider:

- p. 6137, line 14-16: “slight increase in the relative atmospheric humidity” is responsible for the LG-EH paleosol? Today it is dry, so which soils would form in the region?

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Where would you find soils similar to the paleosols today? Could a lower seasonality with possibly increased winter rains explain the transition from aeolian processes to somewhat calcic paleosols (which would require more moisture than before and today)? And could decreasing (westerly?) wind strengths at the end of the Pleistocene play a role? Is there any information about vegetation response at this interval (which could be strongly affected by temperature instead of precipitation and would influence sediment yields and therefore the fluvial system)?

- p. 6138, line 14: “pedological processes ended. . .” – please rephrase this sentence, as the pedological processes themselves have probably not ended (they never end) but either (i) changed in type under changing environmental conditions, or (ii) were outpaced by renewed sedimentation and active fluvial deposition following change in fluvial depositional environment!!!

- p. 6139, line 21-24: The authors infer heavy summer rainfalls during the early Holocene, but how does this combine with the low summer insolation in the Southern Hemisphere during the early Holocene? If the climatic conditions are comparable to today, do we also see comparable pedogenic processes and soils (see above)? This is not mentioned anywhere (and does not seem to be the case), so either (i) climate is not comparable (=different from today, and mean annual precipitation is not a representative measure for overall moisture), or (ii) today the land surface is drier than during the EH (but is this due to climate or fluvial incision and lowered groundwater?).

### 3. Technical comments and minor corrections:

- p. 6127, line 6: “not uniform processes”? Do you mean “not linear”? Or just “variable” in time and space?

- p. 6127, line 15: replace “researches” with “studies”

- p. 6127, line 16: delete “and varied”

- p. 6127, line 20: replace “develops” with “has developed”

- p. 6127, line 22: replace “argentinean” with “Argentinean”
- p. 6127, line 28: insert “the” after “lack”
- p. 6128, line 4: replace “in” with “on”
- p. 6128, line 7: replace “compelling” with “comprehensive”
- p. 6128, line 8: replace “knowledge” with “understanding” or “reconstruction”
- p. 6128, line 10: replace “Frontal” with “frontal”
- p. 6128, line 13: replace “At” with “In”
- p. 6128, line 13-16: cite the stated chronology
- p. 6128, line 18-20: you mention a “conspicuous change in the arrangement of fluvial deposits...”. Which change? From which to which arrangement (depositional environment)? Could you please specify this to help the reader?
- p. 6128, line 23: delete “final”
- p. 6128, line 23: the purpose could be refined, e.g. by mentioning what the relation between micromorphology and climate would be, and therefore which objectives you follow BEFORE addressing the climate significance (e.g. the identification of local-scale pedogenic processes, development and environments)
- p. 6129, line 10-13: rephrase for example to “. . . an ecotone fringe characterized by particularly high sensitivity for past and present atmospheric circulation changes along its margins”.
- p. 6129, line 13: delete comma
- p. 6129, line 14: replace “lands” with “land”
- p. 6129, line 18: delete “its waters”
- p. 6129, line 23 (and throughout the manuscript): check spelling of “Frontal” (either

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“Frontal Cordillera” or “frontal cordillera”)

- p. 6129, line 25: insert “The” before “Frontal”
- p. 6130, line 20: “fluid overflow”? Do you mean overbank deposits? Clarify and replace
- p. 6131, line 1: replace “develops” with “is developed”
- p. 6131, line 12: insert “cemented” before hardpan
- p. 6131, line 12: is this a carbonate hardpan (=calcrete)? Please specify. Also, what is its paleoenvironmental significance (this might be relevant later on in the discussion and comparison of the LG-EH paleosol to more recent analogues?). It does not seem to be developed at the top of the “Puente Roto” and “Finca Gatica” profiles (Fig. 3). . . would this indicate (i) the local and site-specific nature of the hardpan, or (ii) its erosion posterior to 2.7 cal ka BP?
- p. 6131, line 22: replace dot with semicolon after FG
- p. 6132, line 7: delete “a” before 58%
- p. 6132, line 7: could you add a brief note on how the “digital calcimeter” measures CaCO<sub>3</sub>? By pressure, LOI etc?
- p. 6132, line 12: insert “in the field” after paleosol
- p. 6132, line 14: insert “the” before FG
- p. 6132, line 19: replace “in” with “on”
- p. 6132, line 23: delete “a”
- p. 6132, line 24-25: move “observed” to the beginning of sentence
- p. 6133, line 6: replace “aspect” with “appearance”
- p. 6133, line 17-18: “preliminary described Ck or Bk horizon.” Do you mean that

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these horizons are weakly developed? Or that the description was preliminary? Not clear

- p. 6134, line 8: replace “little increment” with “small” or “minor increase”
- p. 6134, line 12: insert “Late Glacial to Early Holocene” before “age”
- p. 6135, line 13 and 16: “dominantly” instead of “dominant”
- p. 6136, line 3: replace “just” with “only”
- p. 6136, line 6: move “including” to before “root”
- p. 6137, line 1: insert “the” before “middle”
- p. 6137, line 8: “thickness” instead of “thick”
- p. 6137, line 19-21: delete sentence; or mention in conclusions/outlook
- p. 6137, line 23: replace “paleosoil” with “paleosol”
- p. 6138, line 6: insert “The” before “C horizon”
- p. 6138, line 10-11: neoformation of gypsum should indicate strong evaporation?!
- p. 6138, line 17: replace “from” with “based on”
- p. 6138, line 19: insert “the” before “lower C horizon”
- p. 6138, line 23: insert “the” before “A horizon”
- p. 6138, line 25: modify to “(with the soil’s upper part being more. . .”
- p. 6138, line 29: replace “sediments” with “sediment”
- p. 6138, line 29: delete “content”
- p. 6139, line 1: replace “was” with “were”
- p. 6139, line 7-8: move “during austral summer” to after “Chaco region”

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- p. 6139, line 10-11: modify to “The flow is characterized by a low-level jet structure and transports. . .”
- p. 6139, line 13-18: long unclear sentence, rephrase and clarify.
- p. 6139, line 25: replace “side” with “sides”
- p. 6139, line 25: replace “occur” with “have occurred”
- p. 6140, line 9: replace “were” with “was”
- p. 6140, line 9: “four pedo-sedimentary cycles”. . . why are four cycles associated with surface stabilization? To me, this seems to describe a rather dynamic oscillation between pedogenic and geomorphic processes.
- p. 6140, line 13: replace “of” with “for”
- p. 6140, line 15: modify to “a well developed paleosol”
- p. 6140, line 25: “subhumid dry climate”? Not clear. Do you mean subhumid? Or dry? Or seasonally changing? Please clarify
- p. 6140, line 29: insert “in the” before “fluvial basins”
- p. 6140, line 29: insert “the” before “Pampas”
- p. 6141, line 6: replace “featured” by “characterized”
- p. 6141, line 16-30: delete this entire paragraph. I cannot see the relevance of the North American “black mats” for the interpretation of the studied paleosol. If anything, I suggest replacing this paragraph with a more comprehensive summary of the extensive literature of climatic changes synchronous to (and therefore potentially relevant for the interpretation of. . .) the studied paleosol-sediment-sequence.
- p. 6142, line 8: “amelioration” – could you specify? Wetter, or warmer, or both?
- p. 6142, line 9: “restricted to the alluvial basins” – how do we know, are there stud-

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ies from hillslopes or elsewhere showing that soils did not form outside of the alluvial basins? Please explain or discuss

- p. 6142, line 11: move “poor” to before “paleosol”
- p. 6142, line 11-12: not clear why “poor paleosol development” was related to the climatic
- p. 6142, line 13: replace “be” with “have been”
- p. 6142, line 16: replace “have” with “provide”
- p. 6142, line 20-23: delete sentence, delete “In such a context”
- p. 6142, line 26: replace “Lateglacial” with “lateglacial” and “Interglacial” with “interglacial”
- p. 6143, line 1-2: I suggest deleting last sentence, seems a bit out of context, and there would be a number of other relevant approaches to future research besides geochemistry alone.
- Fig. 3: Do colours in the stratigraphic logs refer to something? Specify
- Fig. 6: field log of Puente Roto is redundant in this figure as already shown in Fig. 3 and not further investigated for micromorphology etc. Delete from this figure.

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